Air Force Manufacturing Technology For Tactical Grade Interferometric Fiber Optic Gyros (IFOGs)

Persis Elwood
Manufacturing Technology
Wright Laboratory
February 12, 1997

Manufacturing Technology
for
Tactical Grade Interferometric Fiber Optic Gyros

Contract Information

- **Contract Number: F33615-93-C-4321**
- **Awarded: 2 September 1993**
- **Period of Performance: Sep 93 - Aug 97**
- **Contractor:**

  Litton Systems Incorporated

  Guidance and Control Systems Division
- **Contract Value: $15M**

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Specific Objectives

- **Demonstrate IFOG Unit Cost of $1000/axis with a Goal of $500/Axis.**
- **Optimization and Demonstration of Critical Process Capabilities to Meet Cost Objective.**
- **Develop a Robust IFOG Industrial Base.**
  - **Vendor Team Efforts Account for 60% of the Program**
  - **Vendors Establishing Direct Ties with Other IFOG Integrators via Industry Review Board**

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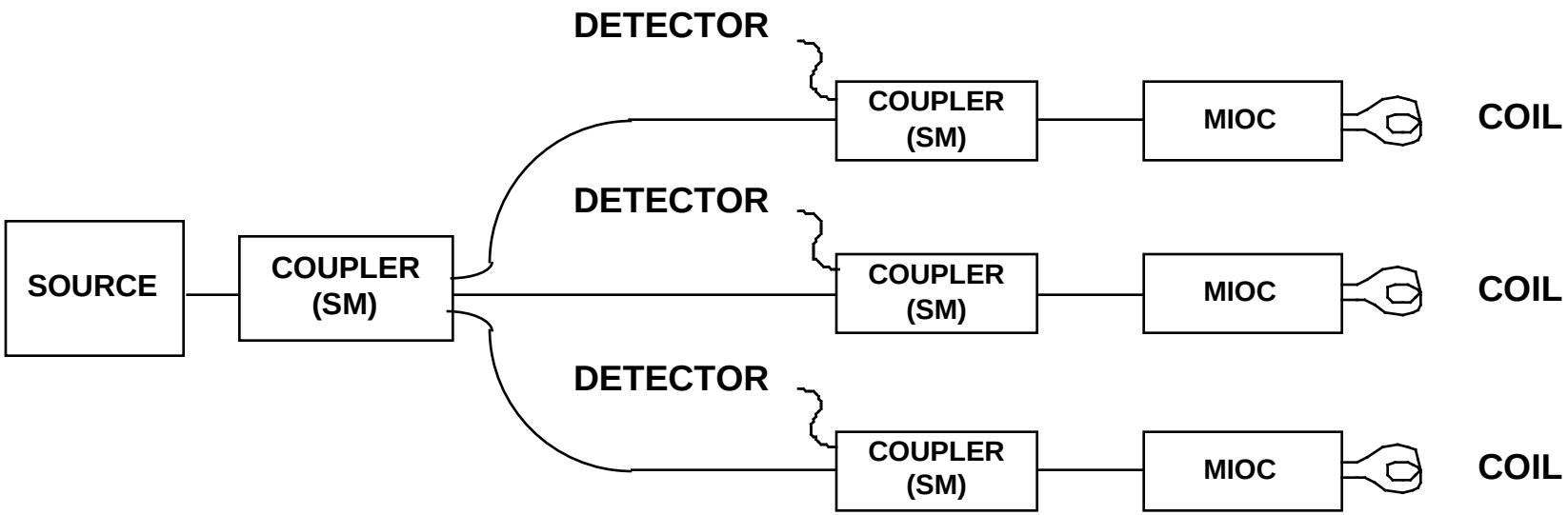
Optical Architecture Triax Configuration #1



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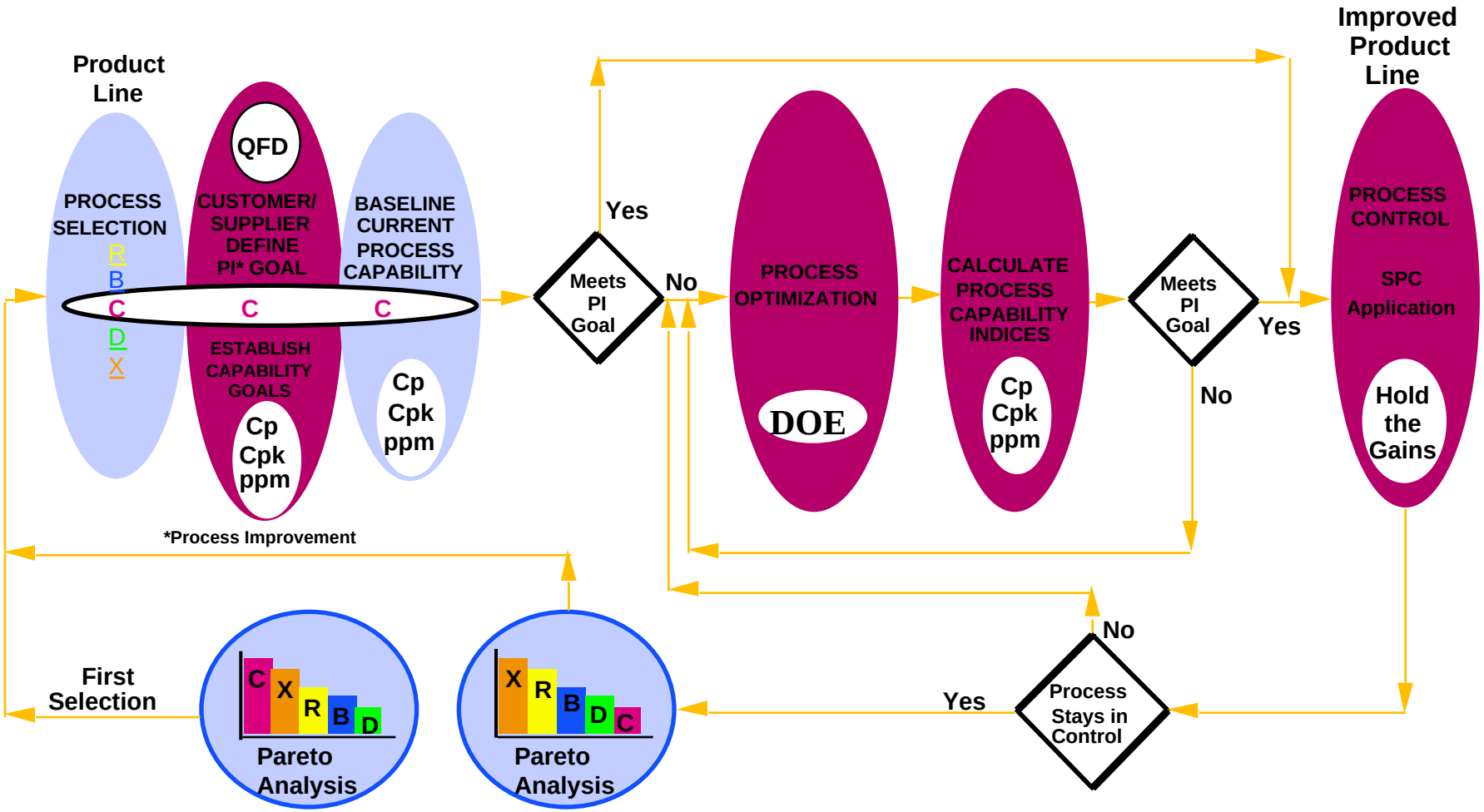
CONTINUOUS PROCESS IMPROVEMENT CYCLE



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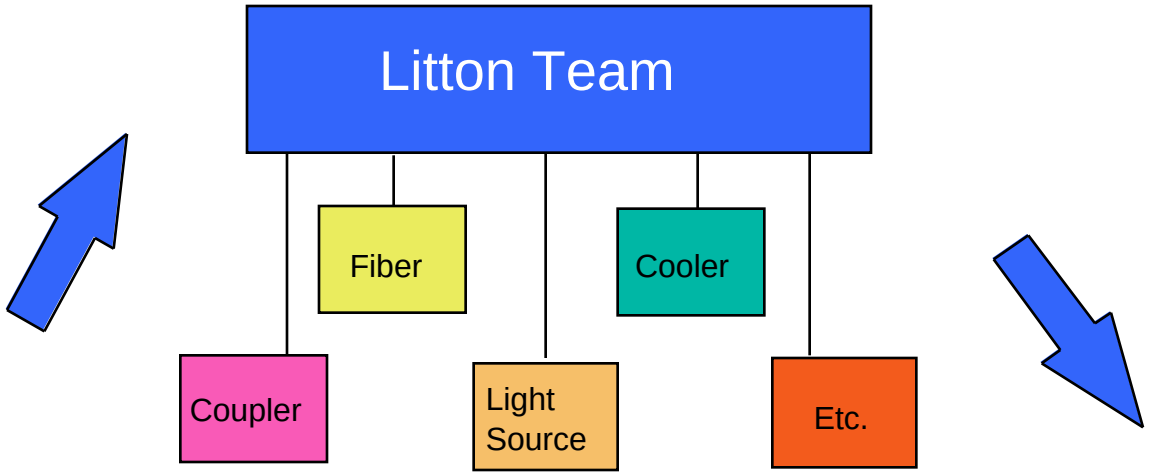

Customer Input

- **AMRAAM Specs**
- **IRB Survey**
- **QFD**

Baseline to Goal

- **Macro & Microflows**
- **Cp & Cpk**
- **Cost**

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Vendor Team

- **EG&G, Optoelectronics -Superluminescent Diode (SLD)**
- **Photonic Packaging Technologies, Inc - Laser Diode**
- **Marlow Industries Inc. - Thermoelectric Cooler (TEC)**
- **3M - Optical Fiber**
- **Pacific Precision Laboratories - Fiber Alignment Stages**
- **Ipitek - Couplers**
- **Ramar Corporation - Integrated Optic Chip (IOC)**
- **Newport Corporation - Power Meter**
- *** Hewlett Packard - High Power Laser**
- *** OPTELECOM, Inc. - Fiber Optic Gyro Coil Winder**

*** Former Team Member**

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Industry Review Board

- Litton
- Smiths Industries
- Honeywell Inc
- Allied Signal Aero. Inc
- Andrew Corp. Products
- Fibersense Technology
- Mercer University
- Corning Inc.
- Tellurex Corp.
- E-Tek
- Ortel Corp
- Amphenol Fiber Optics
- GRC International Inc.
- Vendor Team

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COMPONENT COST

COMPONENT		PROJECTED COSTS		SUPPLIER
		W/O MANTECH	**CURRENT W/MANTECH**	
Laser Diode		**569**	**257**	PPT
SLD		**602**	**280**	EG&G
TEC		**147**	**43**	MARLOW
MIOC		**500**	**70**	RAMAR
SENSING COIL (WOUND)		**73**	**22**	LITTON
FIBER	PM	**$2.25/M**	**$0.49/M**	3M
	SM	**$2.00/M**	**$0.39/M**	
COUPLER	PM	**164**	**82**	IPITEK
	SM	**97**	**33**	

IMU COST MODEL (LASER DIODE)
TRIAX CONFIGURATION

COMPONENT	MAT'L	BURDENED MATERIAL	LABOR HOURS	**TOTAL $**
FOG COILS (3)	294	380	0.9	**446**
MIOC (3)	210	272		**272**
COUPLERS (4) SM	132	171		**171**
LASER DIODE (1)	257	332		**332**
DETECTORS	186	240		**240**
ASSY LABOR			3.0	**219**
MISC PARTS	270	349		**349**
TOTAL TRIAX				**2029**
TOTAL/AXIS				**676**

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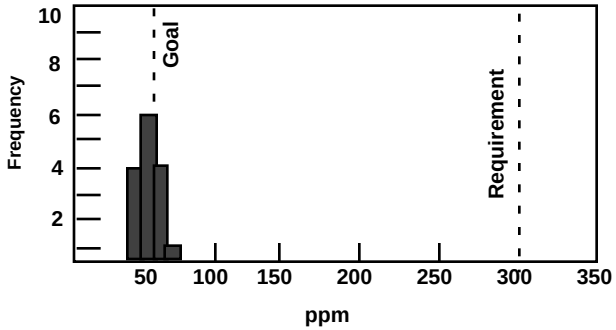
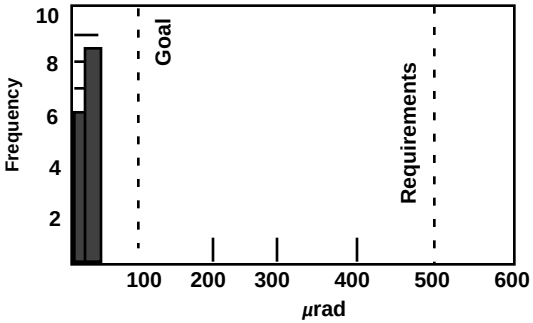
1.5μ GYRO Data
CAL-Verify Over Temperature

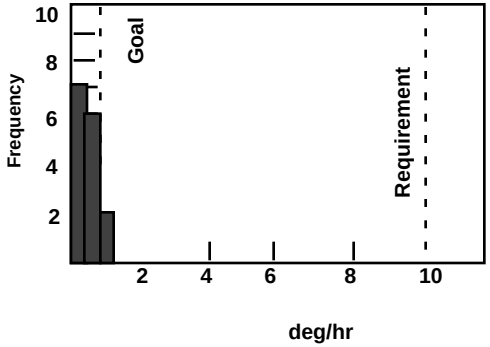
- **15 Gyros Fabricated Using ManTech Components and Litton Production Techniques.**
- **Gyro Test in Progress. System Electronics Used. No Accelerometers.**



Scale Factor - RMS Error
mean = 45.67
sigma = 10.122



Input Axis Stability - RMS
mean = 40.28
sigma = 8.8893



Bias - RMS Error
mean = 0.62
sigma = 0.3301

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Summary of Accomplishments

- **Successful Intermediate Gyro Build (30 Gyros) in Production Environment**
- **Industry Benefits Already Realized with Commercial Availability of Power Meter (Newport Corp) and Fiber Alignment Stage (Pacific Precision Laboratories)**
- **Program Cost Goal of $1K/Axis will be Met or Bettered**
  - **Cost Model Presently - $676/Axis**

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Keys to Affordability

- **Teaming Between Prime and Subs Supported IPPD**
- **AMRAAM Integral Part of Management Team**
  - **Program Planning and Execution**
- **Variability Reduction**
- **Industry Review Board**

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